

# 2nd Mars 2020 Landing Site Workshop - Introduction

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# Guiding Principles:

- Landing site selection is critical to all aspects of 2020 mission and program success (no landing, no science)
- Final site recommendation and selection/approval is the job of the 2020 Science Team, Project, and NASA HQ, respectively.
- ***The broad expertise of the science community is crucial to the identification and evaluation of optimal sites.***
- Process is open to all and has no predetermined outcome


# Basis for 2020 Site Selection:

- Site Must Meet All Engineering Requirements
- Selected Sites Are Best Suited to Achieving 2020 Mission Science Objectives:
  - ✓ Astrobiologically Relevant Environment
  - ✓ Preserve Information to Understand Geological Record – Including Habitability and Preservation Potential
  - ✓ Preserve Materials Preserve Potential Biosignatures
  - ✓ Assemble Sample Cache – Include Igneous Rocks
  - ✓ Consistent with “Technology” Elements

# Participants in 2020 Landing Site Selection:

- **Science Community Input**  
Broad e-mail distribution, Workshop Attendance, Websites
- **Additional Members**  
Blend Experience and Mission Involvement  
Provides for Feed-back on Process
- **NASA-Appointed Landing Site Steering Committee**  
Co-chairs Grant and Golombek  
Other Members Appointed by NASA HQ
- **Mars Characterization Investigators** (MDAP, MFRP, CDP)  
Insight into Landing Site Science and Safety
- **2020 Science Team and Project:**  
Science Team helps identify and evaluate merits of sites  
Engineering teams define the engineering constraints and help analyze aspects of the surface and atmospheric environments.  
Project management and the PSG review scientific analyses of sites.
- **Headquarters and Other Ex-Officios**  
Ensures broad, relevant MEP participation  
Access to Ongoing Mission Data  
Planetary Protection Compliance
- **All Landing Site Selection Activities Documented at:**  
<http://marsnext.jpl.nasa.gov/announcements/index.cfm>

Towards  
Site  
Selection



# Draft 2020 Landing Site Selection Timeline

4-5 Workshops, 4-5 Years, Possible Selection L-2 or L-1 yr

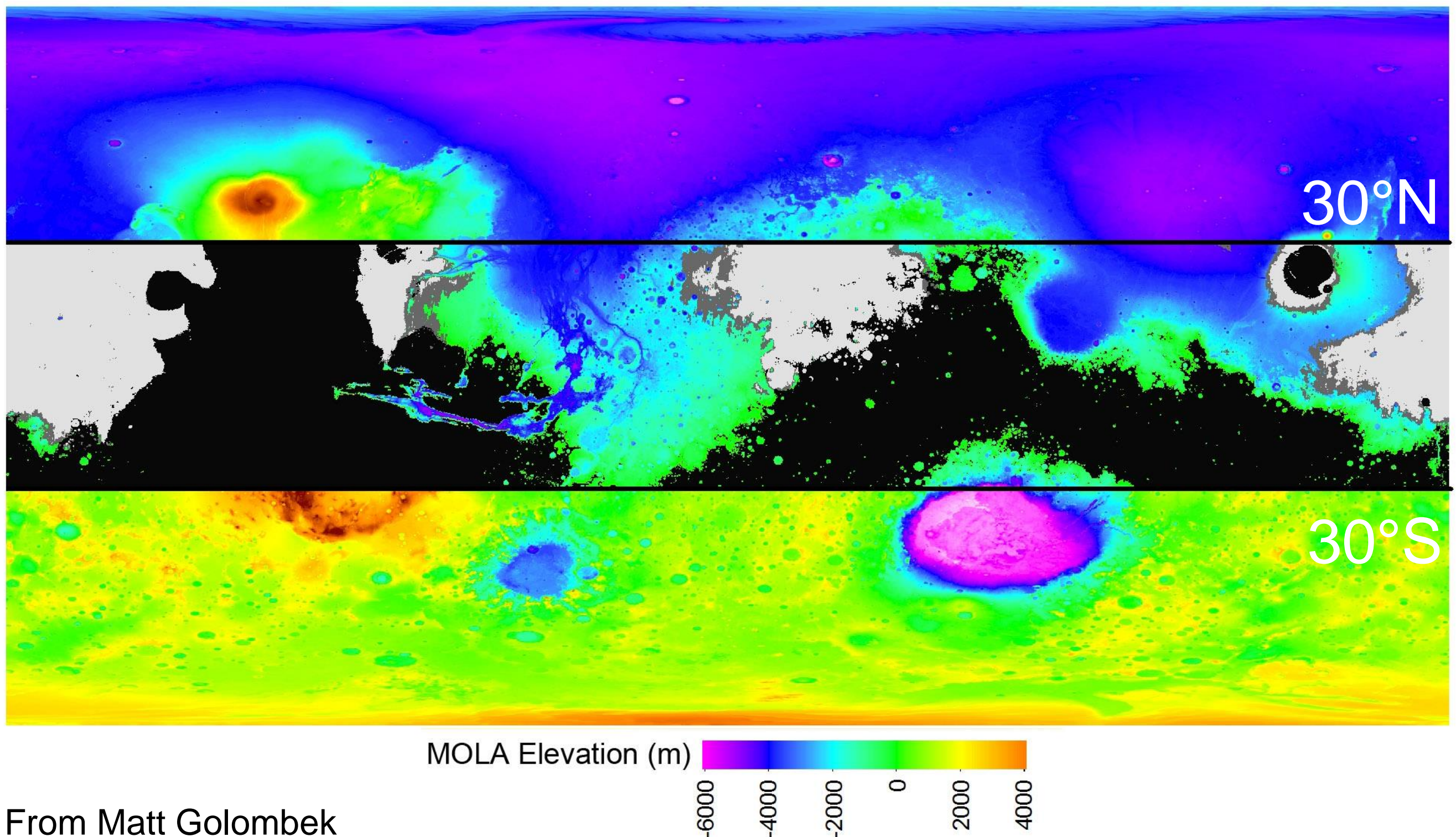
Date	Title	Comments/Description	# of Sites
7/13	SDT report	<ul style="list-style-type: none"><li>• Preliminary engineering constraints</li></ul>	
5/14	LSW 1	<ul style="list-style-type: none"><li>• Sites prioritized into thirds by science merit</li><li>• Top 3<sup>rd</sup> to be characterized for safety and TRN need by LSW 2</li></ul>	~28
6/15	LSW 2	<ul style="list-style-type: none"><li>• Identify 8 selectable sites<ul style="list-style-type: none"><li>- Are there enough non-TRN sites of sufficient science merit?</li><li>- If not, is TRN required? Define TRN attributes needed</li></ul></li></ul>	~8
1/17	LSW 3	<ul style="list-style-type: none"><li>• ~Middle of Phase C</li></ul>	~4
6/18	LSW 4	<ul style="list-style-type: none"><li>• Final planned workshop</li></ul>	~1
7/18	Site selection	<ul style="list-style-type: none"><li>• Decision dependent on number of high priority sites, clustering of sites, programmatic factors</li></ul>	
7/19	LSW 5, if necessary	<ul style="list-style-type: none"><li>• Opportunity for LSW 5 if final site wasn't selected in 2018</li></ul>	
7/20	Launch		



# Where 2020 Can Land:

## Elevation/Lat. Mask with Values of TES Thermal Inertia

- < 150 = dark gray (Christensen et al. 2001)
- < 100 = light gray



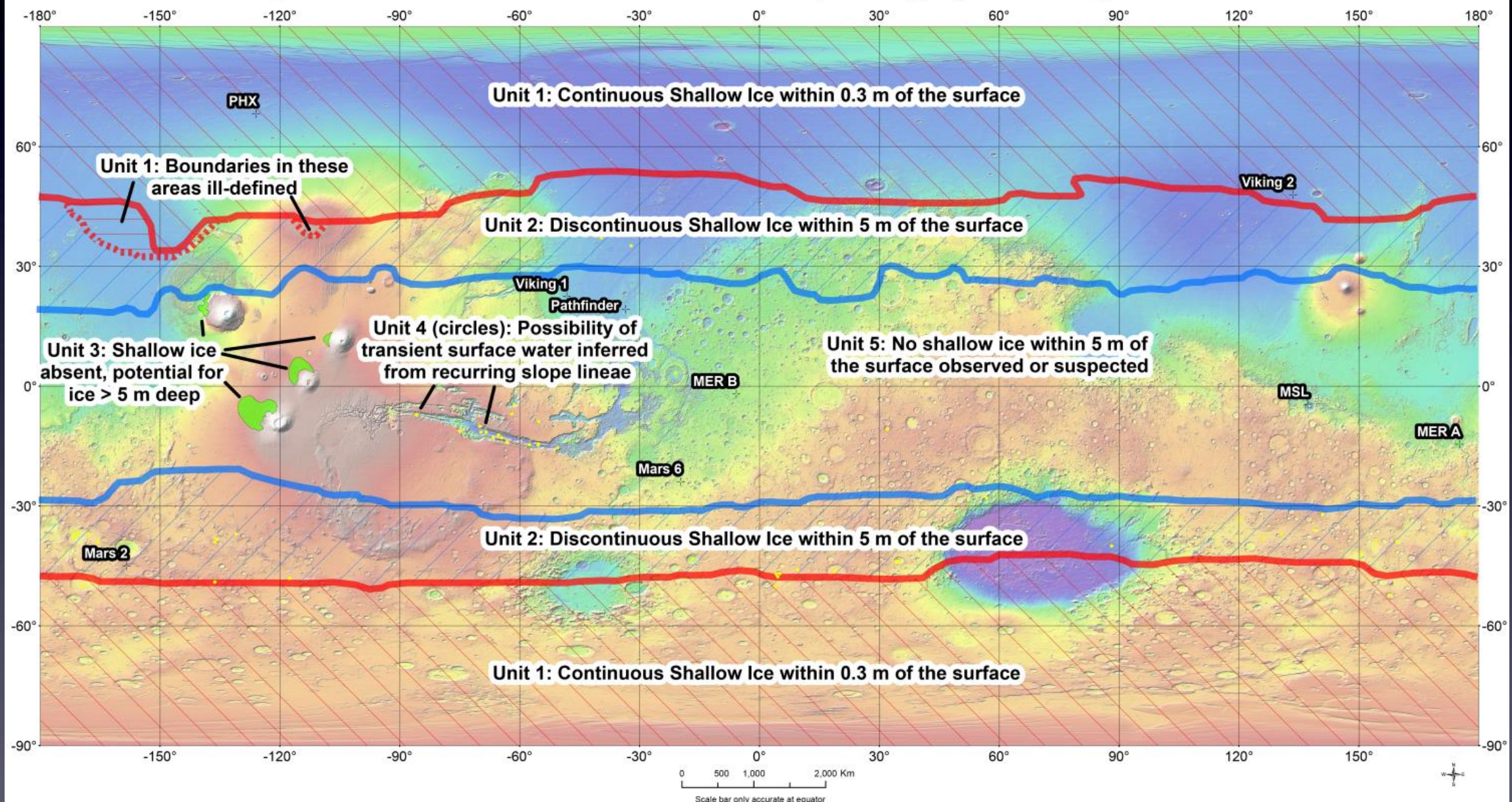


# Planetary Protection Considerations:



## Interpretive Map of Ice and Potential Transient Surface Water on Mars

Map of Features of Relevance to Interpreting Special Regions on Mars



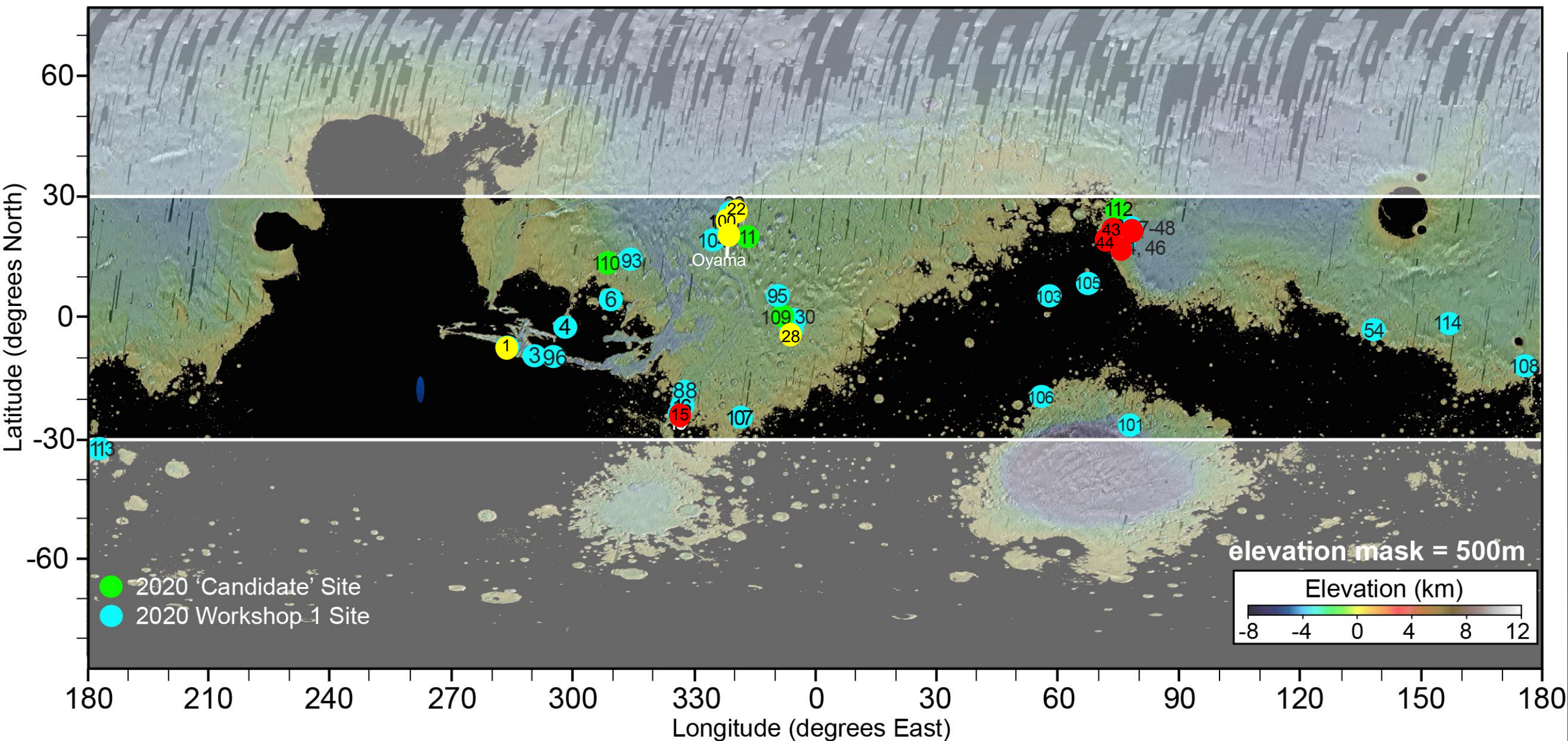
5/12/2014

Special Regions - Science Analysis Group 2

Preliminary results for planning/discussion and review purposes only. For internal use only.



# 2020 Candidate Landing Sites:



## MARS 2020 WORKSHOP SITES (listed in order of presentation schedule, BLUE DOTS)

- |   |  |
|---|--|
| Dot 100: McLaughlin Crater (Michalski, J. et al.)   | Dot 16: Eberswalde Crater (Irwin, R. P., III)  |
| Dot 103: Leighton Crater (Michalski, J. et al.)   | Dot 46: Jezero Crater (Gupta, S., et al. and Ehlmann, B. L., et al.)                                 |
| Dot 22: Mawrth Vallis (Loizeau, D. et al.)  | Dot 88: Ladon Valles (Weitz, C., et al.)   |
| Dot 104: Oxia Planum (Thollot, P., et al.)  | Dot 93: Sabrina Vallis (Platz, T., et al.)   |
| Dot 43: Nili Fossae Trough (Mustard, J. F., et al.)                                       | Dot 113: Eridania Basin (Noe Dobrea, E. Z., et al.)  |
| Dot 48: Nili Fossae Carbonates (Ehlmann, B., et al.)                                      | Dot 107: Kashira crater (Edgett et al.) (2020 Candidate Site from M. R. Salvatore)                   |
| Dot 44: NE Syrtis Major (Mustard, J. F., et al.)  | Dot 28: Eastern Margaritifer Terra (Christensen, P., et al.)   |
| Dot 105: Nili Patera (Skok, J. R., et al.) (2020 Candidate Site from Skok, J. R., et al.) | Dot 101: Hadriacus Palus (Skinner, J. A., et al.)  |
| Dot 106: Hellas (Noe Dobrea, E. Z., et al.)   | Dot 95: Firsoff Crater (Pondrelli, M., et al.) (2020 Candidate Site from Pondrelli et al.)           |
| Dot 3: Melas Chasma (Miyamoto et al.) (2020 Candidate Site from S. M. R. Turner, et al.)  | Dot 108: Gusev Crater (Ruff, S. W. et al.; Longo, A.; Rice, J.) (2020 Cand. Site from Cabrol et al.) |
| Dot 4: Juventae Chasma (Miyamoto et al.)  | Dot 54: Gale Crater (Grant, J.)  |
| Dot 1: Melas Basin (Williams, R. M. E., et al.)   | Dot 30: Meridiani Planum (M. Golombek)   |
| Dot 96: Coprates Chasma (Quantin, C., et al.)   | Dot 15: Holden Crater (Irwin, R.)  |
| Dot 6: Hypanis delta in Xanthe Terra (Gupta, S., et al.)                                  | Dot 114: Aeolis (Yakovlev, V)  |

## MARS 2020 CANDIDATE SITES (GREEN DOTS)

- Dot 109: Farthest West Meridiani (Edgett et al.)
- Dot 110: Vistula Valles/Chryse (Edgett et al.)
- Dot 111: Intercrater West Arabia (Edgett et al.)
- Dot 112: Nilosyrtris crater (Saper, L)



# First Workshop Outcome:

Candidate Landing Site	Weighted Average*	Need for Additional Imaging by	Is Site Likely Land On or Go To?	Is Range Trigger Likely Needed for Access?	Does Range Trigger Reduce the Need for TRN?	Does Access Likely Require TRN?	If Go To, Would TRN Likely Make Land On?
NE Syrtis	2.78	High	Mostly Land On	Yes	Probably	Probably	No
Nili Fossae Trough	2.59	Low	Mostly Go To	No	Yes	Yes	No
Nili Fossae Carbonates	2.56	Low	Land On	Yes	No	Yes	No
Jezero Crater Delta	2.33	Low	Partially Go To	No	No	Yes, to avoid rocks	No
Holden Crater	2.24	Low	Go To	No	No	No	Possibly
McLaughlin Crater, 21.85N, 337.73E, -5.05km	2.24	Medium	Mostly Land On	No	Probably	?	?
Southwest Melas Basin	2.22	Low	Land On	Yes	No	Probably Not	No
Mawrth Vallis, MSL Site	2.16	Low	Land On	No	No	No	No
East Margaritifer Chloride	2.13	Low	Land On	No	No	Yes	No
Oyama Crater, clay layers	2.13	Medium	Land On	No	No	No	No
Eberswalde Delta	1.98	Low	Go To	No	No	No	No
Ladon Valles	1.97	Medium	Land On	No	No	No	Yes
Gusev Crater	1.91	Low	Land On	No	No	No	No
Oxia Planum, clay layers, Mawrth like	1.80	High	Land On	No	Probably	Probably	No
Nili Patera Hydrothermal	1.84	Medium	Mostly Go To	?	?	?	?
Hadriacus Palus	1.71	High	Land On	No	Yes	Not with RT Ellipse	No
Hypanis Delta	1.65	Medium/High	Land On and Go To	No	Yes	?	?
Kashira Crater	1.66	High	Go To	Maybe	?	?	Probably
Circum-Hellas Hydrothermal	1.55	Medium	Go To	No	?	?	?
Coprates Chasma	1.52	Medium	Mostly Go To	No	Probably	Probably	No
Sabrina Vallis	1.42	Medium	Partially Go To	No	Yes	No	No
Gale Crater	1.36	Low	Go To	No	No	No	No
Firsoff Crater	1.32	High	Land On	No	No	No	No
Valles Marineris - Melas Chasma Floor, RSL	1.32	Medium	Go To	No	?	?	?
Valles Marineris - Coprates Chasma, RSL	1.28	Medium	Go To	No	?	?	?
Valles Marineris - Juventae Chasma, RSL	1.22	Medium	Go To	No	?	?	?
Meridiani Planum	1.10	Low	Land On	No	No	No	No

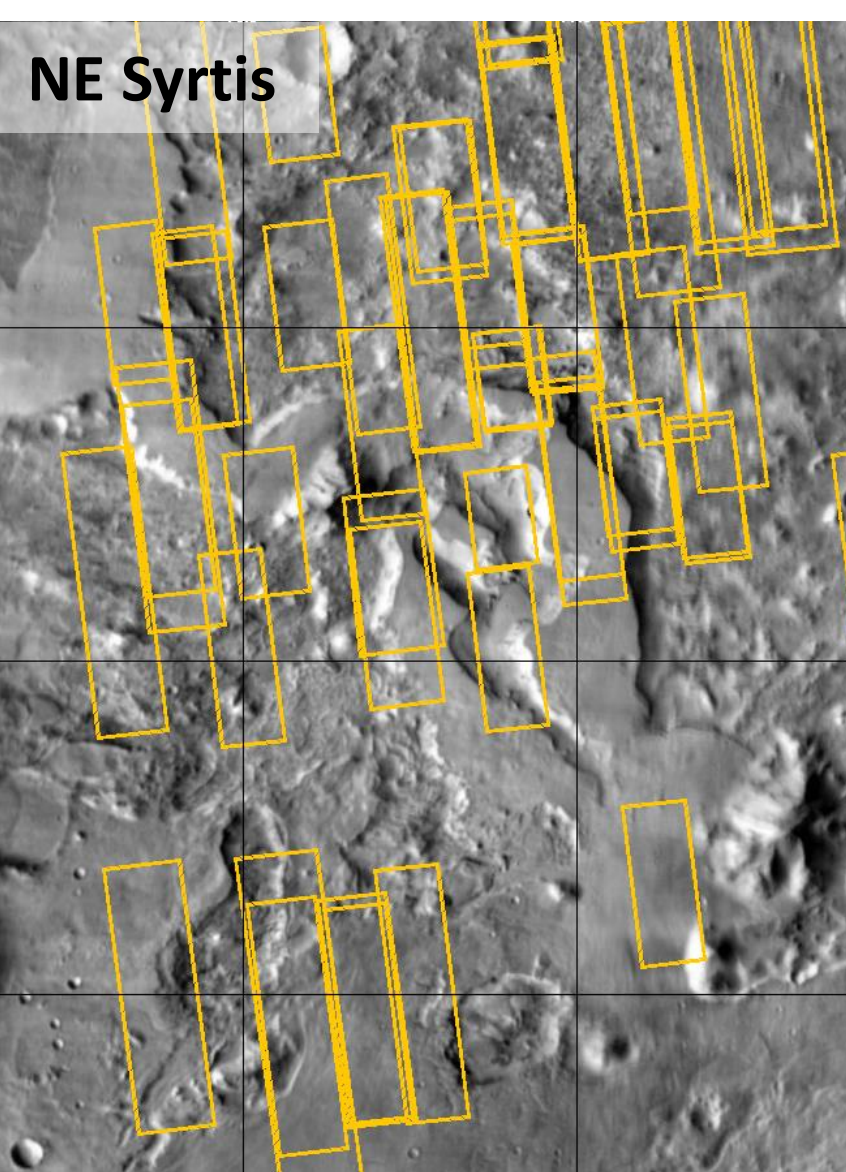
\* Voted on each site using High (3), Med (2), Low (1)



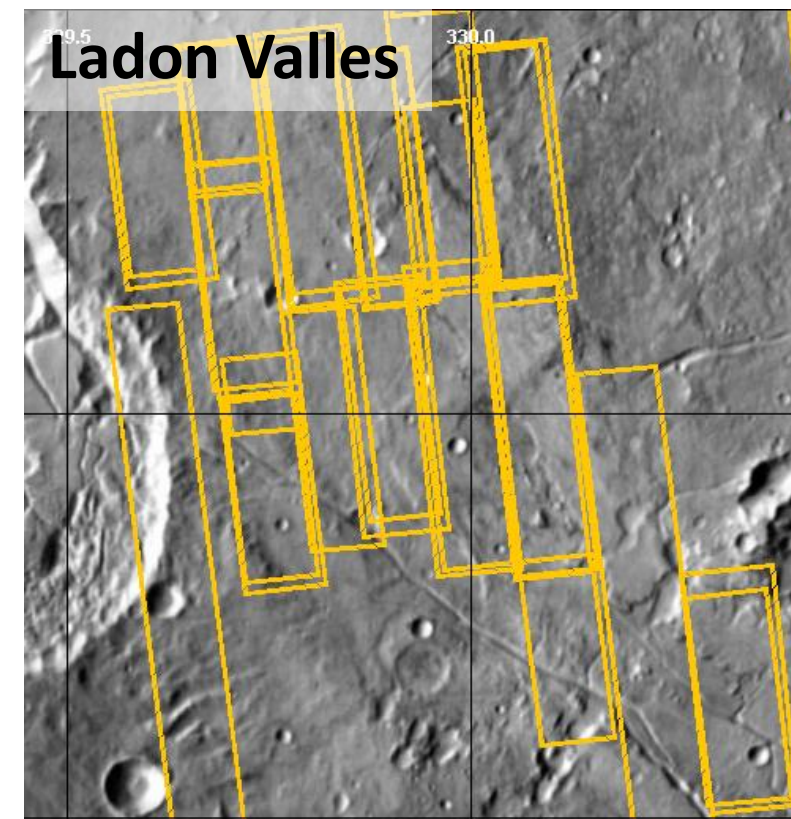
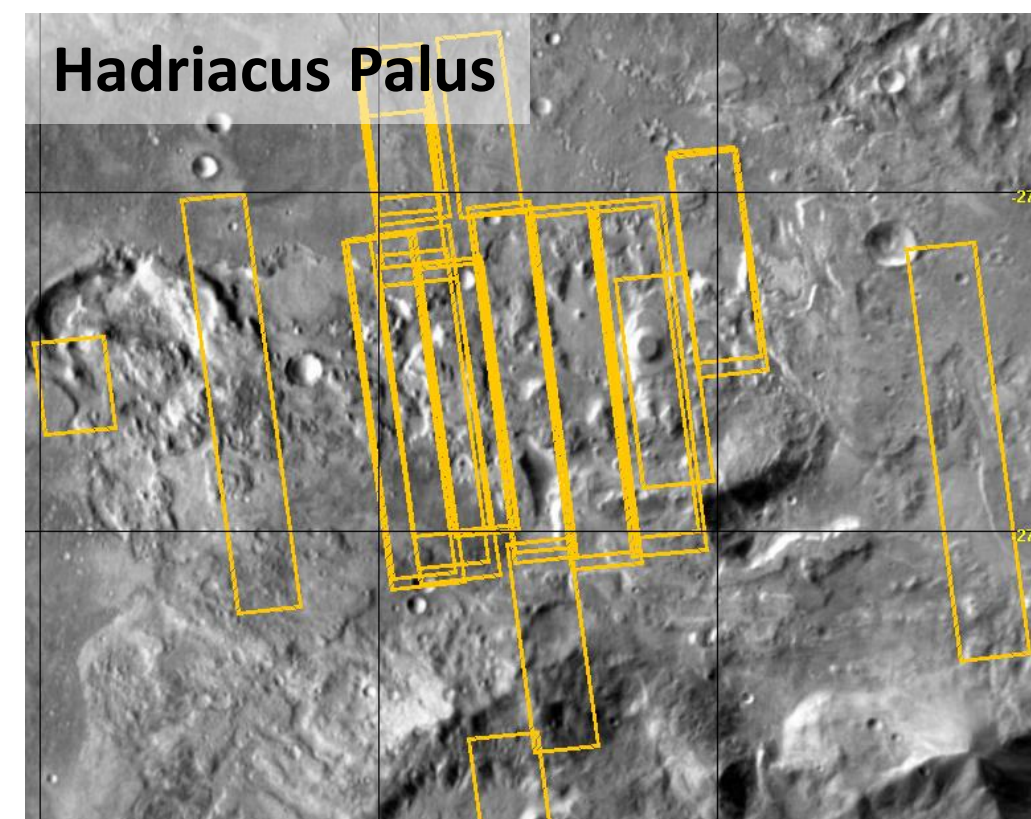
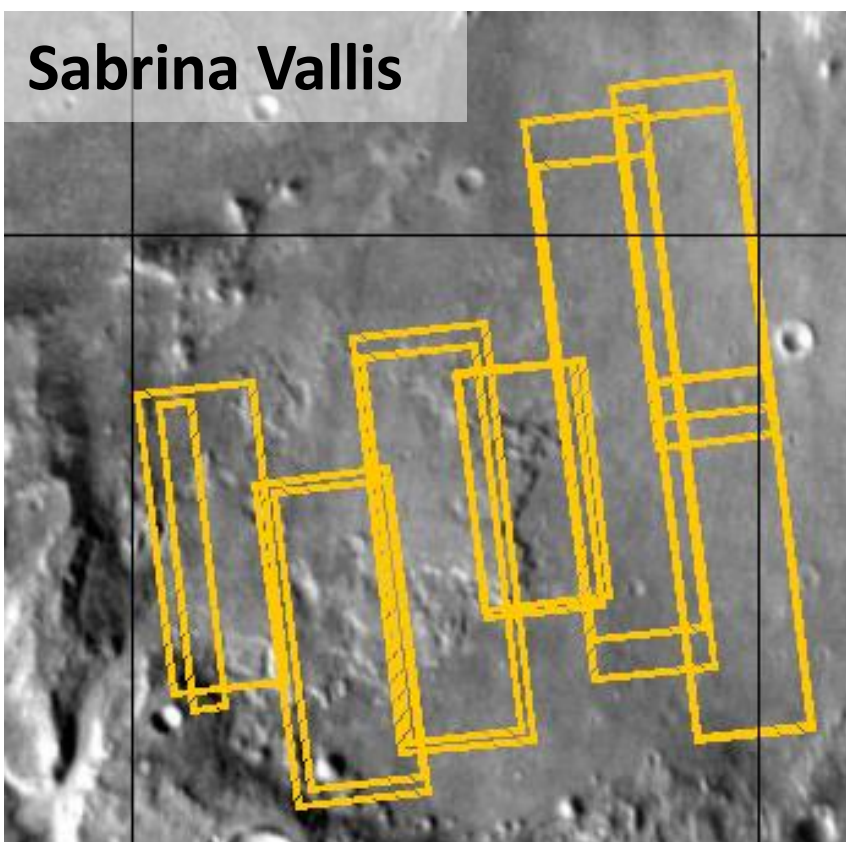
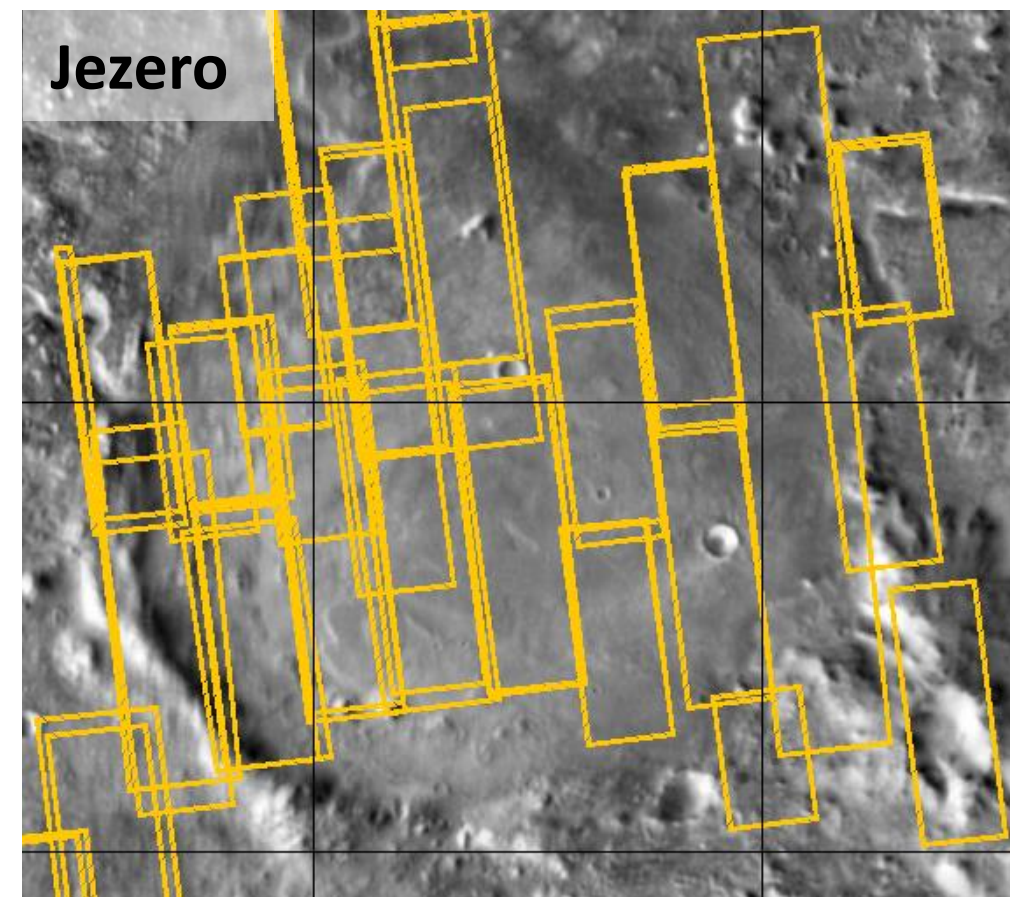
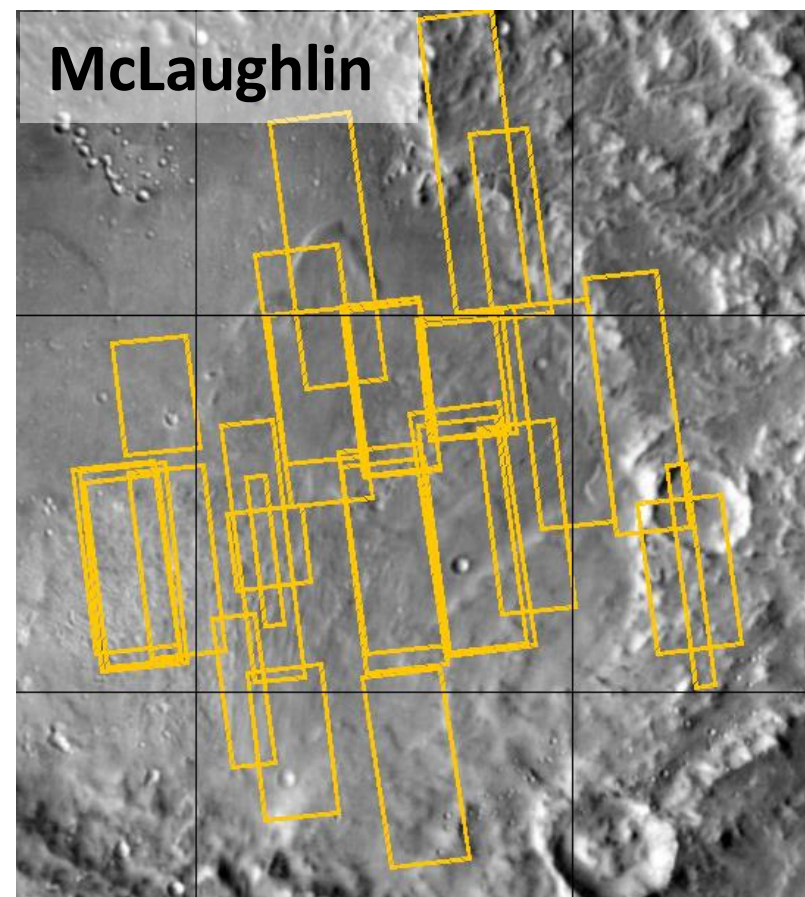
# Status for 2020 Sites Requesting HiRISE Images

	LOCATION	# TARGETS	REQUESTED STEREO PAIRS	COMPLETE IMAGES	REQUESTED IMAGES	REMAINING IMAGES
1	<u>Nilosytris crater</u>	2	2	4	4	COMPLETE
2	<u>Inter crater W. Arabia</u>	3	3	6	6	COMPLETE
3	<u>Vistula Valles/Chryse</u>	3	3	5	6	1 (S2)
4	<u>Farthest W. Meridiani</u>	3	3	6	6	COMPLETE
5	<u>Nili Patera</u>	3	2 (+1 stereo 2)	5	5	COMPLETE
6	<u>Hadriacus Palus</u>	3	3	5	6	1 (S2)
7	<u>Oyama crater</u>	6	2 (+1 stereo 2)	7	8	1 (S2)
8	<u>Firsoff crater</u>	5	3	7	8	1 (S2)
9	<u>Jezero crater</u>	4	4	7	8	1 (S2)
10	<u>Sabrina Vallis</u>	3	2 (+1 stereo 2)	4	5	1 (S2)
11	<u>Nili Carbonate</u>	1	0	1	1	COMPLETE
12	<u>Kashira crater</u>	7	5	11	12	1 (S2)
13	<u>NE Syrtis</u>	9	4 (+ 1 stereo 2)	10	13	3 (S2)
14	<u>Hypanis</u>	2	2	3	4	1 (S2)
15	<u>Melas Chasma/East Melas</u>	4	3 (+ 1 stereo 2)	5	5	COMPLETE
16	<u>Capri</u>	1	0	1	1	COMPLETE
17	<u>Coprates Chasma</u>	2	0	2	2	COMPLETE
18	<u>Oxia Planum</u>	6	1	6	7	1 (S2)
19	<u>Gusev</u>	6	5	10	11	1 (S2)
20	<u>Nili Fossae Trough</u>	4	2	6	6	COMPLETE
21	<u>McLaughlin crater</u>	3	3	5	6	1 (S2)
22	<u>Ladon Vallis</u>	1	1	2	2	COMPLETE
23	<u>Eridania</u>	5	3	4	8	4 (2S1, 2S2)
	TOTAL	86	56 (+ 5 stereo 2s)	122	140	18 (2S1, 16S2)





# HiRISE Coverage for Select Landing Sites





# Landing Site Rubric:

**Scientific Criteria:** Reflective of both the Mars-2020 SDT report and the Decadal Survey\* (key Mars questions driving return of samples)

## Mars 2020 Mission and Decadal Priority Science Factors

Landing Site Factor

Environmental Setting for Biosignature Preservation and Taphonomy of Organics

Type 1A & 1B Samples: Aqueous Geochemical Environments indicated by Mineral Assemblages

Type 2 Samples : Igneous

Context: Martian History Sample, Timing Constraints

Oldest stratigraphic constraint

Youngest stratigraphic constraint

Landing sites listed here (currently not a complete list)

Two purposes: (1) describe the diversity of geologic settings/paleoenvironment types, (2) relate to biosignature preservation, e.g. Summons et al., 2011 report

Three purposes: (1) describe the diversity of aqueous geochemistry as indicated by minerals/assemblages, (2) describe the diversity of igneous materials, (3) relate to the Type 1A, 1B, 2 samples desired for return indicated by the e2e-iSAG and adopted by the 2020 SDT report

Geologic context is crucial for being able to use results from the site to constrain global-scale issues (see below)

These columns are designed to collect information about \*scientific\* site characteristics in tabular form (see key at right). These columns catalog diversity but do not attempt to rank the importance of different characteristics relative to one another. This debate must be held by the community, once it is armed with specific facts about what is present at each site. The intent of this side of the rubric is to compile those facts for easy comparison between sites.

### Key

●	Yes (in-ellipse)
○	Yes (out of ellipse)
	No
~	Partial Support or Debated
?	Indeterminate
	TBD

Yes (in vs. out of ellipse) and No provide straightforward summaries of site data.

The ~ is to be used when there is controversy about a claim, either due to insufficient data or multiple competing hypotheses. The ? is to be used when it is agreed the answer is unknowable or indeterminate.

Example 1  
your site  
here

These criteria assess the degree to which: (1) key time periods in very early Mars geologic history are investigated (access to the time of early atmospheric loss, magnetic field and its demise, LHB as called out in the Decadal survey Q3, Table 3.1), (2) whether it is known what geologic time periods would be explored based on time brackets (units, cross-cutting relationships) that provide upper and lower bounds relative to the established Martian chronology; (3) whether the stratigraphy accessible to the rover is "organized"; (4) whether there specifically exists a unit that could be sampled with an emplacement age (preferred: crystallization age) well-constrained by



# Scientific Selection Criteria:

## Objective A

- 1. The geologic setting and history of the landing site can be characterized and understood through a combination of orbital and in-situ observations.

## Objective B

- 2a. The landing site offers an ancient habitable environment.
- 2b. Rocks with high biosignature preservation potential are available and are accessible to investigation for astrobiological purposes with instruments on board the rover.

## Objective C

- 3a. The landing site offers an adequate abundance, diversity, and quality of samples suitable for addressing key astrobiological questions if and when they are returned to Earth.
- 3b. The landing site offers an adequate abundance, diversity, and quality of samples suitable for addressing key planetary evolution questions if and when they are returned to Earth.

Votes will be made on each candidate site using each of the criteria listed above. Each person will vote once per site per criteria, with Green=5 points, Yellow=3 points, Red=1 point



# Summary of Workshop Deliverables:

- Science community provides input on the merits of the candidate sites, Project recommends site to NASA, NASA selects the site.
- Provide a list of top ~8 sites to Project for further consideration:
  - Rank the candidate sites as green, yellow, red based relative to science selection criteria
  - **Green** = 5 points, **Yellow** = 3 points, **Red** = 1 point
  - Each person votes on each criteria for each site
  - Similar to what was done for MER and MSL
  - Results comprise science input to the merits of the candidate sites
- Additional factors influence identification of ~8 remaining sites:
  - Engineer criteria (EDL and operations constraints), Planetary Protection, etc
- The list of sites emerging from the workshop may be different from that recommended by the Project:
  - Engineers and Science Teams are here and participating and will vote
  - They will hear the same results and interpretations that we do
  - The Project will meet after the workshop (will include community representation)